THE AMINO ACID DEFICIENCIES OF SOYBEAN PROTEIN

BY

LOUIS-PHILIPPE BOUTHILLIER

M. S., Université de Montréal,
Montreal, Canada, 1936.

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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Introduction

Among the various vegetable proteins, those of the soybean may offer excellent possibilities in human nutrition to extend and partially replace proteins of animal origin. It is well recognized that the biological quality of a protein is dependent upon the distribution and the amounts of the constituent essential amino acids. The following experiments were undertaken with the purpose of establishing by the rat growth procedure exactly which essential amino acids, if any, are present in inadequate amounts in soybean proteins furnished at a level of *18 per cent* of the ration.

Experimental

The soybean flour which supplied the proteins in the diets was of the expeller type. The cooking of the soybean flour was performed by mixing the meal with sufficient distilled water to make a thin paste, and autoclaving for one hour and a half at 15 pounds pressure. The product was dried in the air to its initial weight and was ground to a fine powder.

A crude protein fraction analogous to glycinin was obtained from the Illini variety of soybeans by extraction of the defatted flour with a 10 per cent sodium chloride solution. The protein was precipitated and finally dehydrated by treatment with ethyl alcohol. The cooked glycinin was prepared in the same manner as the cooked soybean flour.

In most cases, the nitrogen content of the diet administered to the negative control animals was made equal to that of the experimental ration by the addition of a suitable amount of glycine. Albino rats weighing 42 to 65 grams were used as the experimental animals. The total amount of food consumed and the total gain in weight for a period of 32 days were recorded.

The effect of supplementing soybean protein with methionine was first studied. The positive control diet contained 0.6 per cent of *dl*-methionine. These experiments have demonstrated that the supplementation of soybean protein with methionine has a growth-promoting effect. This is in accord with the findings of Hayward and Hafner (1) and Almquist and co-workers (2).

The effect of heat on the nutritive value of soybean flour was next investigated. In one series of experiments, the animals were fed diets containing, respectively, the cooked and uncooked soybean flour, no methionine being added. The term "cooked" as used here implies the application of additional heat over and above that which the product received during the process of manufacture. In another series of experiments, the basal diets were supplemented with 0.6 per cent of *dl*-methionine. It has been found that the application of heat to the particular brand of flour used in these tests does not improve the nutritive quality of the product.

Feeding experiments were conducted to study the effect of varying the protein level in the basal ration. For this purpose, diets were employed containing respectively 13, 18 and 23 per cent of soybean protein in the form of soybean flour. The results indicate that in the absence of added methionine a diet containing 23 per cent of soybean protein possesses a somewhat higher nutritive quality than one containing 18 per cent of this protein. The supplementary effect of methionine on these basal rations was also studied. Each diet was supplemented with 0.6 per cent of *dl*-methionine. It appears that 18 per cent of soybean protein induces approximately optimum growth, provided the slight deficiency of methionine is compensated for by the addition of this amino acid to the ration.

In order to determine whether any amino acid other than methionine might be furnished in sub-optimal quantity in a diet carrying 18 per cent soybean protein, experiments were undertaken in which the supplementing effect of each of the essential amino acids was tested. In all experiments methionine was included in the food. The experimental data reveal the fact that the addition of the essential amino acids to diets containing 18 per cent soybean protein supplemented with methionine does not improve the nutritive quality of the protein.

A series of feeding experiments was conducted in which the growth-promoting properties of casein and soybean flour were compared, each at a level of 18 per cent of protein, with and without the addition of methionine. Evidence was obtained that casein induces distinctly better growth than does unsupplemented soybean flour at the same level of protein intake, but that soybean flour supplemented with methionine supports just as rapid gains as does casein supplemented with methionine. One additional experiment involved a comparison of the gains of animals upon 12 and 15 per cent protein in the form of casein and soybean flour. Methionine was incorporated in each ration in equal amounts, namely, 0.6 per cent. The results indicate that soybean protein even at dietary levels of 12 and 15 per cent appears to support just as satisfactory gains as does casein at like levels of intake provided sufficient methionine is incorporated in the food.

Study was made of the supplementing effect of valine and methionine on the nutritive value of a crude protein fraction analogous to glycinin but obtained from the Illini variety of beans. Diets were prepared which contained 18 per cent of the uncooked or the cooked protein. These diets were supplemented respectively with 0.7 per cent of *dl*-valine, 0.6 per cent of *dl*-methionine, and both amino acids at the same respective levels. The results demonstrate that with uncooked or cooked glycinin, methionine shows a positive effect on growth. On the contrary, the addition of valine to the crude uncooked or cooked glycinin fails to cause any improvement in growth.

Summary

Using the growth method, feeding experiments have been conducted upon rats to obtain definite information concerning the amino acid deficiencies of the mixed proteins of soybean flour. The results demonstrate that methionine is the only essential amino acid which exists in sub-optimal amount in soybean protein when the latter is fed at a level of 18 per cent.

Heating the particular brand of soybean flour employed in these investigations does not improve its nutritive quality.

Casein is superior in nutritive value to the mixed proteins of soybean flour unless the latter is supplemented with methionine. The inclusion of methionine in the soybean diet enables the subjects to grow as rapidly as when they receive their nitrogen in the form of casein.

Bibliography

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Vita

The author was born October 1st, 1912 at Montreal, P. Que., Canada, where he received his elementary and high school education. He attended Univers té de Montréal from which he received his "Licence ès sciences chimiques" in June 1935 and the degree of Master of Science in 1936. He held at this institution from 1936 to 1941 Research and Teaching Assistantships in Physiological Chemistry. In the fall of 1941, he entered the Graduate School of the University of Illinois. In 1941, the Rockfeller Foundation granted him a fellowship which was renewed for a second year.